POCKET

REF

Thomas J. Glover

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Compiled by

Thomas J. Glover

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Preface

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The information in this manual was collected from numerous sources and if not properly acknowledged, Sequoia Publishing, Inc. would like to express its appreciation for those contributions. See page 6 for specific trade name, trade mark, and credit information.

My deepest thanks to my and the following people for their tremendous effort in helping make the 3rd edition a reality:

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Mary Glover - Research, photography, and writer
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Millie Young - 2nd Edition page layouts

A very special I love you and thanks goes to my wife Mary. Her patience, love, and understanding, not to mention her spoiling me to death, allow me to survive the rigors of the publishing world.

Thomas

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Personal Information

Name →					
Birthday					
Anniversary					
Favorite color					
Chest					
Gloves					
Hat					
Hips					
Inseam					
Neck					
Ring Size					
Shirt / Blouse					
Shoe					
Shoulder to Waist					
Sleeve Length					
Sock / Hose					
Suit/Dress					
Sweater					
Waist /belt					

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References, Trade Names and Trade Marks

The following are Trade Names and Trade Marks included in Pocket Ref. If we missed your Trade Name or Trade Mark, we apologize, please let us know and we will insert it in the next printing.

AWS – American Welding Society
ANSI – American National Standards Institute
ASCII – American Standard Code for Information Interchange
Brown & Sharp
Cedarapids – Iowa Manufacturing Co.
ISO – International Organization for Standardization
Metropolitan Life Insurance Company
NCHS – National Center for Health Statistics
NEMA – National Electrical Manufacturers Association
Pioneer – Portec Pioneer Division
ROMEX –
SAE – Society of Automotive Engineers

Some of the references used in writing Pocket Ref include the following (They are all excellent references and should be added to any good reference library):

American Society of Heating, Refrigerating and Air Conditioning
Arco's New Complete Woodworking Handbook – J. T. Adams, Arco
Builders Vest Pocket Reference – W.J. Hornumg, Prentice–Hall,Inc
Cedarapids Reference Book – Iowa Manufacturing Company
Dana's Manual of Minerology – E.S. Dana, John Wiley & Sons
Electronic Engineers Master Catalog – Hearst Business Communications Inc.
Field Geologists Manual – Australian Institute of Mining and Met.
Grainger Catalog– W. W. Grainger, Inc
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Machinery's Handbook – E.O. & F.D. Jones, Industrial Press Inc
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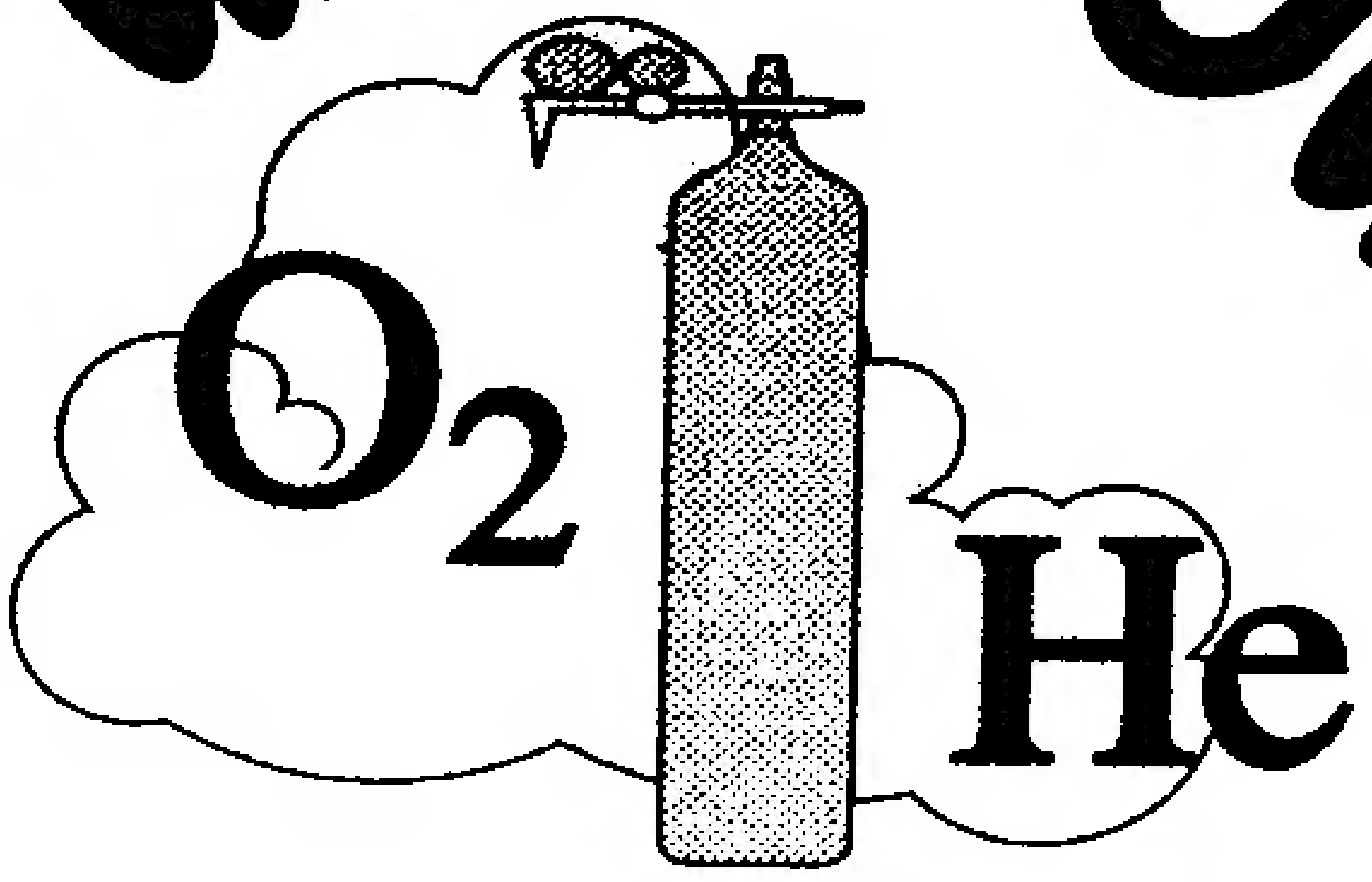
Mechanical Engineers' Handbook – McGraw–Hill Book Co., Inc.
National Electrical Code – National Fire Protection Association
Pioneer Facts and Figures – Portec, Pioneer Division
Scientific Tables – Ciba–Geigy Ltd, New York
Standard Math Tables – The Chemical Rubber Co.
Technical Reference Handbook – E. P. Rasis, American Tech. Pub.
The Universal Almanac, 1995 - J.W.Wright, Andrews & McMeel
The World Almanac – Pharos Books
Water Well Handbook – K.E. Anderson, Missouri Water Well Assn.

NOTE. There are many more references, most of which are referenced on specific pages in Pocket Ref. If we have omitted a reference, we apologize, please let us know and we will include it in the next printing of Pocket Ref.

Air and Gases



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(See WATER for Cyl. Fillage & Pollution, p. 634)

Composition Of Air

Component of Air	Symbol	Content – %Volume	
Nitrogen	N_2	78.084 percent	99.998%
Oxygen	O_2	20.947 percent	
Argon	Ar	0.934 percent	
Carbon dioxide	CO_2	0.033 percent	
Neon	Ne	18.2 parts/million	
Helium	He	5.2 parts/million	
Krypton	Kr	1.1 parts/million	
Sulfur dioxide	SO_2	1.0 parts/million	
Methane	CH_4	2.0 parts/million	
Hydrogen	H_2	0.5 parts/million	
Nitrous oxide	N_2O	0.5 parts/million	
Xenon	Xe	0.09 parts/million	
Ozone	O_3	0.0 to 0.07 parts/million	
Ozone – Winter	O_3	0.0 to 0.02 parts/million	
Nitrogen dioxide	NO_2	0.02 parts/million	
Iodine	I_2	0.01 parts/million	
Carbon monoxide	CO	0.0 to trace	
Ammonia	NH_3	0.0 to trace	

The above table is an average for clean, dry air at sea level.
1 part/million = 0.0001 percent.

Physical Properties of Air

Density of dry air at Standard Temperature and Pressure

1.29274 kilograms/cu meter = 0.080703 pounds/cu foot

Universal Gas Constant (R): 0.08206 liter atmosphere/mole kelvin
8.31451 joule/mole kelvin

Standard Reference Conditions

(also known as Standard Temperature and Pressure - STP)

Standard Temperature = 0°C = 32°F = 273.15 K

Standard Pressure = 760 mm Hg =
14.696 pounds-force/sq inch = 2116.22 pounds-force/sq foot =
29.92 inch Hg = 1.01325 x 10^5 N/m^2 = 1.01325 x 10^5 Pa =
101.325 kPa

Speed of sound in dry air at STP

331.45 meters/sec = 1087.4 ft/sec = 741.4 miles/hr

ICAO Sea Level Air Standard Values

Atmospheric pressure = 760 mm Hg = 14.7 lbs-force/sq inch

Temperature = 15°C = 288.15 K = 59°F

Densities of Gases

Gas	Density (grams/liter)	Density (lb/cu ft)
Air @ STP	1.2928	0.08071
Air @ 59°F	1.2256	0.07651
Argon	1.7837	0.111353
Carbon Dioxide	1.9770	0.123420
Carbon Monoxide	1.2500	0.078035
Helium	0.1785	0.011143
Hydrogen	0.0899	0.005612
Neon	0.8999	0.056179
Nitrogen	1.2506	0.078072
Oxygen	1.4290	0.089210

All densities listed above assume a dry gas at standard temperature (0°C) and pressure (760 mm Hg) and under those conditions, one mole of any gas will occupy a volume of 22.41 liters = 0.02241 cubic meters = 0.7914 cubic feet.

Standard Atmosphere

The unit "1 Standard Atmosphere" is defined as the pressure equivalent to that exerted by a 760 mm column of mercury at 0°C (32°F), at sea level, and at standard gravity (32.174 ft/sec^2). Atmospheric pressure is the weight of a column of air per area unit as measured from the top of the atmosphere to the reference point being measured. Atmospheric pressure decreases as altitude increases.

Equivalents to 1 atmosphere are as follows:

76 centimeters (760 mm) of mercury
29.921 inches of mercury
10.3322 meters of water
406.782 inches of water
33.899 feet of water
14.696 pounds-force per square inch
2,116.2 pounds-force per square foot
1.033 kilograms-force per square centimeter
101.325 kilopascal

General Gas Laws & Formulas

Perfect Gas Law

$$PV = nRT$$

P=Pressure in atmospheres
V=Volume in liters n=Number of moles
R=Gas constant (0.0821 liter-atmospheres / K / mole)
T=Temperature in K
If constant pressure $V1/V2 = T1/T2$
If constant temperature $P1/P2 = V2/V1$
If constant volume $P1/P2 = T1/T2$

Boyle's Law

emperature is kept constant, the volume of a given mass of gas inversely proportional to the pressure which is exerted upon it.

$$\frac{\text{Initial Pressure}}{\text{Final Pressure}} = \frac{\text{Final Volume}}{\text{Initial Volume}}$$

Charles' Law

If the pressure is constant, the volume of a given mass of gas is directly proportional to the absolute temperature.

$$\frac{\text{Initial Volume}}{\text{Initial Temperature K}} = \frac{\text{Final Volume}}{\text{Final Temperature K}}$$

Dalton's Law of Partial Pressures

The pressure which is exerted on the walls of a vessel is the sum of the pressures which each gas would exert if it were present alone.

$$PV = V\,(p_1 + p_2 + \dots p_n)$$

Graham's Law of Diffusion

Relative rates of diffusion of two gases are inversely proportional to the square roots of their densities.

Avogadro's Law

Equal volumes of gases, measured under the same conditions of temperature and pressure, contain equal numbers of molecules.

Air Velocity in a Pipe

$$V = \sqrt{\frac{25{,}000\,DP}{L}}$$

V = Air velocity in feet per second
D = Pipe inside diameter in inches
L = Length of pipe in feet
P = Pressure loss due to air friction in ounces-force/square inch

Using this equation and typical values of V, D, and L; approximate values of P are computed as follows:

Velocity	Pipe Diameter in inches, 10 feet long				
Ft/Sec	1	2	4	6	10
1	0.0004	0.0002	0.0001	0.00007	0.00004
2	0.0016	0.0008	0.0004	0.0003	0.00016
5	0.0100	0.005	0.0025	0.0017	0.001
10	0.04	0.02	0.01	0.0067	0.004
15	0.09	0.045	0.0225	0.015	0.009
20	0.16	0.08	0.04	0.027	0.016
25	0.25	0.125	0.0625	0.0417	0.025
30	0.36	0.18	0.09	0.06	0.036

(Formula from B.F. Sturtevant Co)

Air Volume Discharged from Pipe

$$CFM = 60VA$$

CFM = Air volume in cubic feet per minute
V = Air velocity in feet per second as determined in the equation at the top of this page.
A = Cross section area of pipe in square feet.

Theoretical Horsepower to Compress Air

$$HP = 0.2267\,Q\left[\left[\frac{PSI}{14.7} + 1\right]^{0.283} - 1\right]$$

HP = Theoretical horsepower
Q = System air flow rate in cubic feet per minute
PSI = Outlet gage pressure in pounds-force per square inch
Conditions: (1) dry air at sea level, atmospheric pressure =
14.7 psi (2) single stage adiabatic compression

Density of Moist Air

mm Hg	Air Temperature (Dew Point =10°C) 0°C	10°C	20°C	40°C	60°C
1000	1.695	1.635	1.579	1.479	1.390
975	1.653	1.594	1.540	1.441	1.355
950	1.610	1.553	1.500	1.404	1.320
925	1.568	1.512	1.461	1.367	1.285
900	1.525	1.471	1.421	1.330	1.250
875	1.482	1.430	1.381	1.293	1.215
850	1.440	1.389	1.342	1.256	1.181
825	1.397	1.348	1.302	1.219	1.146
800	1.355	1.307	1.262	1.182	1.111
775	1.312	1.266	1.223	1.145	1.076
760	1.287	1.241	1.199	1.122	1.055
750	1.270	1.225	1.183	1.108	1.041
725	1.227	1.184	1.144	1.071	1.006
700	1.185	1.143	1.104	1.033	0.971
675	1.142	1.102	1.064	0.996	0.937
650	1.100	1.061	1.025	0.959	0.902
625	1.057	1.020	0.985	0.922	0.867
600	1.015	0.979	0.945	0.885	0.832
575	0.972	0.938	0.906	0.848	0.797
550	0.930	0.897	0.866	0.811	0.762
525	0.887	0.856	0.827	0.774	0.727
500	0.845	0.815	0.787	0.737	0.692
475	0.802	0.774	0.747	0.700	0.658
450	0.760	0.733	0.708	0.663	0.623
425	0.717	0.692	0.668	0.625	0.588
400	0.674	0.651	0.628	0.588	0.553
375	0.632	0.610	0.589	0.551	0.518
350	0.589	0.569	0.549	0.514	0.483
325	0.547	0.528	0.510	0.477	0.448
300	0.504	0.487	0.470	0.440	0.414
275	0.462	0.446	0.430	0.403	0.379
250	0.419	0.405	0.391	0.366	0.344
225	0.377	0.363	0.351	0.329	0.309
200	0.334	0.322	0.311	0.292	0.274
175	0.292	0.281	0.272	0.254	0.239
150	0.249	0.240	0.232	0.217	0.204
125	0.207	0.199	0.193	0.180	0.169
100	0.164	0.158	0.153	0.143	0.135
75	0.122	0.117	0.113	0.106	0.100

Moist air density (gms/liter) = 1.2929 x (273.13/T) x ((P–Vp)/760)

T=Absolute air temperature (Kelvin)

P=Barometric pressure (mm of mercury)

Vp=Vapor pressure of water (see table in WATER Chapter)

Elevation vs. Air & Water

Elevation		US Std Atmosphere		Boiling Point	Speed Sound
Meters	Feet	Temp °F	Pressure lbf/sq in	H_2O(°F)	m/sec
–1000	–3281	70.7	16.52	218.5	344.1
–500	–1640	64.9	15.59	215.2	342.2
0	0	59.0	14.70	212.0	340.3
250	820	56.1	14.26	210.4	339.3
500	1640	53.2	13.85	208.8	338.4
750	2461	50.2	13.44	207.2	337.4
1000	3281	47.3	13.03	205.7	336.4
1250	4101	44.4	12.64	204.1	335.5
1500	4921	41.5	12.26	202.6	334.5
1750	5741	38.5	11.89	201.0	333.5
2000	6562	35.6	11.53	199.5	332.5
2500	8202	29.8	10.83	196.5	330.6
3000	9843	23.9	10.17	193.5	328.6
3500	11483	18.1	9.54	190.6	326.6
4000	13123	12.2	8.94	187.7	324.6
4500	14764	6.4	8.38	184.8	322.6
5000	16404	0.5	7.84	182.0	320.5
5500	18045	–5.3	7.33	179.2	318.5
6000	19685	–11.1	6.85	176.4	316.5
6500	21325	–17.0	6.39	173.7	314.4
7000	22966	–22.8	5.96	171.0	312.3
7500	24606	–28.6	5.56	168.4	310.2
8000	26247	–34.5	5.17	165.8	308.1
8500	27887	–40.3	4.81	163.2	305.9
9000	29528	–46.2	4.47	160.7	303.8
9500	31168	–52.0	4.15	154.4	301.7
10000	32808	–57.8	3.84	151.3	299.5
11000	36089	–69.5	3.29	145.0	295.2
12000	39370	–69.5	2.81	138.9	295.1
13000	42651	–69.5	2.41	133.0	295.1
14000	45932	–69.5	2.06	127.0	295.1
15000	49213	–69.5	1.74	121.3	295.1
16000	52493	–69.5	1.50	115.7	295.1
17000	55774	–69.5	1.28	110.3	295.1
18000	59055	–69.5	1.10	104.7	295.1
19000	62336	–69.5	.94	99.7	295.1
20000	65617	–69.5	.80	94.5	295.1
25000	82021	–60.9	.37	70.5	298.4
30000	98425	–52.0	.17	49.3	301.7
32000	104987	–48.5	.13	41.5	303.0

Data in table based on ICAO Standard Atmosphere

Dry Air Specific Heat & Sound Velocity at 1 Atmosphere, Various Temperatures

Specific Heat (also known as Specific Heat Capacity) is defined at either constant pressure (c_p) or constant volume (c_v).
The Specific Heat Ratio (c_p / c_v) is dimensionless.

Temperature °C	Temperature °F	Specific Heat (c_p) Btu$_{I}$ / lb °F*	Specific Heat (c_p) kJ / kg K	Ratio c_p / c_v	Sound Velocity ft / s	Sound Velocity m / s
-173	-280	0.2456	1.028	-	651	198.4
-163	-262	0.2440	1.022	1.4202	685	208.8
-153	-244	0.2430	1.017	1.4166	717	218.5
-143	-226	0.2423	1.014	1.4139	747	227.7
-133	-208	0.2418	1.012	1.4119	776	236.5
-123	-190	0.2414	1.011	1.4102	804	245.1
-113	-172	0.2411	1.009	1.4089	831	253.3
-103	-154	0.2408	1.008	1.4079	856	260.9
-93	-136	0.2406	1.007	1.4071	882	268.8
-83	-118	0.2405	1.007	1.4064	906	276.1
-73	-100	0.2404	1.007	1.4057	930	283.5
-68	-91	0.2403	1.006	1.4055	941	286.8
-63	-82	0.2403	1.006	1.4053	953	290.5
-58	-73	0.2403	1.006	1.4050	964	293.8
-53	-64	0.2402	1.006	1.4048	976	297.5
-48	-55	0.2402	1.006	1.4046	987	300.8
-43	-46	0.2402	1.006	1.4044	998	304.2
-38	-37	0.2402	1.006	1.4042	1008	307.2
-33	-28	0.2401	1.005	1.4040	1019	310.6
-28	-19	0.2401	1.005	1.4038	1030	313.9
-23	-10	0.2401	1.005	1.4036	1040	317.0
-18	0	0.2401	1.005	1.4034	1051	320.3
-13	8	0.2401	1.005	1.4032	1061	323.4
-8	17	0.2402	1.006	1.4030	1071	326.4
-3	26	0.2402	1.006	1.4029	1081	329.5
2	35	0.2402	1.006	1.4026	1091	332.5
7	44	0.2402	1.006	1.4024	1101	335.6
12	53	0.2402	1.006	1.4022	1111	338.6
17	62	0.2403	1.006	1.4020	1120	341.4
20	68	0.2403	1.006	1.4019	1126	343.3
22	71	0.2403	1.006	1.4018	1130	344.4
27	80	0.2404	1.007	1.4017	1140	347.5
32	89	0.2404	1.007	1.4015	1149	350.2
37	98	0.2405	1.007	1.4013	1158	353.0
42	107	0.2405	1.007	1.4010	1167	355.7
47	116	0.2406	1.007	1.4008	1177	358.7
52	125	0.2407	1.008	1.4006	1186	361.5
57	134	0.2407	1.008	1.4004	1195	364.2
62	143	0.2408	1.008	1.4001	1204	367.0
67	152	0.2409	1.009	1.3999	1213	369.7

Dry Air Specific Heat & Sound Velocity at 1 Atmosphere, Various Temp (cont.)

Temperature		Specific Heat (c_p)		Ratio	Sound Velocity	
°C	°F	Btu_{IT} / lb °F*	kJ / kg K	c_p / c_v	ft / s	m / s
72	161	0.2410	1.009	1.3996	1221	372.2
77	170	0.2411	1.009	1.3993	1230	374.9
82	179	0.2411	1.009	1.3990	1239	377.6
87	188	0.2412	1.010	1.3987	1247	380.1
92	197	0.2413	1.010	1.3984	1256	382.8
97	206	0.2415	1.011	1.3981	1264	385.3
102	215	0.2416	1.012	1.3978	1273	388.0
107	224	0.2417	1.012	1.3975	1281	390.4
112	233	0.2418	1.012	1.3971	1289	392.9
117	242	0.2420	1.013	1.3968	1298	395.6
122	251	0.2421	1.014	1.3964	1306	398.1
127	260	0.2422	1.014	1.3961	1314	400.5
137	278	0.2425	1.015	1.3953	1330	405.4
147	296	0.2428	1.017	1.3946	1346	410.3
157	314	0.2432	1.018	1.3938	1361	414.8
167	332	0.2435	1.019	1.3929	1377	419.7
177	350	0.2439	1.021	1.3920	1392	424.3
187	368	0.2443	1.023	1.3911	1407	428.9
197	386	0.2447	1.025	1.3901	1421	433.1
207	404	0.2451	1.026	1.3892	1436	437.7
217	422	0.2456	1.028	1.3881	1450	442.0
227	440	0.2460	1.030	1.3871	1464	446.2
237	458	0.2465	1.032	1.3861	1478	450.5
247	476	0.2469	1.034	1.3851	1492	454.8
257	494	0.2474	1.036	1.3840	1506	459.0
267	512	0.2479	1.038	1.3829	1520	463.3
277	530	0.2484	1.040	1.3818	1533	467.3
287	548	0.2490	1.043	1.3806	1546	471.2
297	566	0.2495	1.045	1.3795	1559	475.2
307	584	0.2500	1.047	1.3783	1572	479.1
317	602	0.2506	1.049	1.3772	1585	483.1
327	620	0.2511	1.051	1.3760	1597	486.8
347	656	0.2522	1.056	1.3737	1622	494.4
367	692	0.2533	1.061	1.3714	1647	502.0
387	728	0.2545	1.066	1.3691	1671	509.3
407	764	0.2556	1.070	1.3668	1695	516.6
427	800	0.2568	1.075	1.3646	1718	523.6
447	836	0.2579	1.080	1.3623	1742	531.0
467	872	0.2591	1.085	1.3601	1764	537.7
487	908	0.2602	1.089	1.3580	1787	544.7
507	944	0.2613	1.094	1.3559	1808	551.1
527	980	0.2624	1.099	1.354	1830	557.8
577	1070	0.2653	1.111	1.349	1883	573.9
627	1160	0.2678	1.121	1.345	1934	589.5

Dry Air Specific Heat & Sound Velocity at 1 Atmosphere, Various Temp (cont.)

Temperature		Specific Heat (c_p)		Ratio	Sound Velocity	
°C	°F	Btu_{IT} / lb °F*	kJ / kg K	c_p / c_v	ft / s	m / s
677	1250	0.2704	1.132	1.340	198	605.0
727	1340	0.2728	1.142	1.336	2032	619.4
827	1520	0.2774	1.161	1.329	2126	648.0
927	1700	0.2817	1.179	1.322	2215	675.1
1027	1880	0.2860	1.197	1.316	2300	701.0
1127	2060	0.2900	1.214	1.310	2381	725.7
1227	2240	0.2940	1.231	1.304	2459	749.5
1327	2420	0.2984	1.249	1.299	2535	772.7
1527	2780	0.3076	1.288	1.288	2676	815.6
1727	3140	0.3196	1.338	1.274	2807	855.6
2127	3860	0.3760	1.574	1.238	3033	924.5
2527	4580	0.5396	2.259	1.196	3225	983.0

* Btu_{IT} / lb °F is also equal to Btu_{IT} / lb °R = cal_{IT} / g °C = cal_{IT} / g K
Btu_{IT} / lb °F = 4186.8 J / kg K

1 atmosphere (atm) is equal to the following:

14.7 psia
0.101325 MN/m^2
0.101325 MPa
1.01325 x 10^5 Pa

For ideal gases, the specific heat capacities differ by R, the molar gas constant, as shown in the following equation:
$c_p - c_v = R = 8.31$ J / mole / K

Source: Tables of the Thermal Properties of Gases, National Bureau of Standards Circular 564, November 1955

Dry Air Specific Heat at 20°C Constant Temperature and Various Pressures

Specific Heat (also known as Specific Heat Capacity) is defined at either constant pressure (c_p) or constant volume (c_v).
The Specific Heat Ratio (c_p / c_v) is dimensionless.

Specific Heat values in this table are based on a constant Temperature of 20°C = 68°F = 293 K

Pressure	c_p	c_p/c_v
0.01 atm 0.147 psia 0.00101325 MN/m^2	0.2399	1.4002
0.1 atm 1.47 psia 0.0101325 MN/m^2	0.2400	1.4003
0.4 atm 5.88 psia 0.04053 MN/m^2	0.2401	1.4008
1 atm 14.7 psia 0.101325 MN/m^2	0.2403	1.4019
7 atm 102.9 psia 0.70928 MN/m^2	0.2427	1.4131
10 atm 147 psia 1.01325 MN/m^2	0.2440	1.4188
40 atm 588 psia 4.053 MN/m^2	0.2569	1.4763
70 atm 1029 psia 7.0928 MN/m^2	0.2700	1.5323
100 atm 1470 psia 10.1325 MN/m^2	0.2824	1.5828

Source: Tables of the Thermal Properties of Gases, National Bureau of Standards Circular 564, November 1955

Air Tool Requirements

Tool Category	Tool cfm
Air Filter Cleaner	3
Air Hammer	4
Air Hoist 1000#	5
Air Motor 1 hp	6–10
Air Motor 2 hp	12–15
Air Motor 3 hp	18–20
Bead Breaker	12*
Bench Rammer	5
Body Polisher	2
Body Orbital Sander	5
Brake Tester	4
Burr Tool – small	4
Burr Tool – large	5–6
Carbon Remover	3
Chain Saw	7–22
Circle Saw – 8 inch	12
Circle Saw – 12 inch	17
Compression Riviter	1
Die Grinder	4–6
Drill 1/16–3/8 inch	4–6
Drill 3/8–5/8 inch	7–8
Dust blow gun	3
File/Saw Machine	3–5
Floor Rammer	7
Grease Gun	3*
Grinder – 2 in Horz	5–10
Grinder – 4 in Horz	15
Grinder – 6 in Horz	15–17
Grinder – 8 in Horz	20
Grinder – 5 in Vert	8–10
Grinder – 7 in Vert	14–15
Grinder – 9 in Vert	17–20
Hammer – Chip	8
Hammer – Fender	9
Hammer – Rivet	8–15
Hammer – Scale	3–4
Hammer – Tire	12
Hoist – Cyl type	2

Tool Category	Tool cfm
Hydr Lift 8000 lb	6*
Hydr Floor Jack	6*
Impact Wrenches:	
1/4 inch drive	3
3/8 inch drive	2–5
1/2 inch drive	4–8
3/4 inch drive	7–9
1 inch drive	10
1 1/4 inch drive	14
Nutsetter – 3/8 inch	3–6
Nutsetter – 3/4 inch	5–8
Pneu. Garage Door	3*
Radiator Tester	1
Rammers – small	3
Rammers – medium	9
Rammers – large	10
Sander – 5 in Pad	8–10
Sander – 7 in Pad	15
Sander – 9 in Pad	17–20
Screwdriver #2–#6	1–3
Screwdriver #6–up	3–6
Spray Cleaner	5
Spray Paint Guns:	
Standard	5
Production	9
Touch–up	4
Undercoat	19
Tamper Backfill	6–15
Tapper – 3/8 inch	3–5
Tire Changer	1*
Tire inflation	2*
Tire Rim Stripper	6*
Tire Spreader	1*
Transmission Flusher	3

NOTE: Most tools listed above are rated at 90 to 100 pounds-force/sq inch, however, those items with a “*” next to the cfm rating require 125 to 160 pounds-force/sq inch.

Always check the manufacturers recommendations for both air pressure (psi – pounds-force per sq inch) and air flow (cfm – cubic feet per minute) requirements. The ratings listed above are only averages based on a 25% load factor (running 25% of the time).

CFM vs. PSI for Nozzles

Gauge PSI	CFM Free Air Flow @ Nozzle Diameter (inch)			
	1/64	1/32	3/64	1/16
1	0.03	0.11	0.2	0.4
5	0.06	0.24	0.5	1.0
10	0.08	0.34	0.8	1.4
15	0.11	0.42	0.9	1.7
20	0.12	0.49	1.1	2.0
25	0.14	0.56	1.3	2.2
30	0.16	0.63	1.4	2.5
40	0.19	0.77	1.7	3.1
50	0.23	0.92	2.1	3.7
60	0.26	1.06	2.4	4.2
70	0.30	1.20	2.7	4.8
80	0.33	1.34	3.0	5.4
90	0.37	1.48	3.3	5.9
100	0.41	1.62	3.7	6.5
110	0.44	1.76	4.0	7.1
120	0.48	1.91	4.3	7.6
130	0.51	2.05	4.6	8.2
140	0.55	2.19	4.9	8.8
150	0.58	2.33	5.2	9.3
175	0.67	2.68	6.0	10.7
200	0.76	3.04	6.8	12.1
PSI	3/32	1/8	3/16	1/4
1	1.0	1.7	3.9	6.8
5	2.2	3.9	8.7	15.4
10	3.1	5.4	12.3	21.8
15	3.8	6.7	15.1	26.9
20	4.4	7.9	17.7	31.4
25	5.1	9.0	20.2	35.9
30	5.7	10.1	22.8	40.5
40	7.0	12.4	27.9	49.5
50	8.2	14.6	32.9	58.6
60	9.5	16.9	38.0	67.6
70	10.8	19.2	43.1	76.7
80	12.1	21.4	48.2	85.7
90	13.3	23.7	53.3	94.8
100	14.6	26.0	58.4	104.0
110	15.9	28.2	63.5	113.0
120	17.1	30.5	68.6	122.0
130	18.4	32.7	73.7	131.0
140	19.7	35.0	78.8	140.0
150	21.0	37.3	83.9	149.0
175	24.2	42.9	96.6	172.0
200	27.3	48.6	109.0	194.0

PSI = pounds-force/square inch; CFM = cubic feet/minute
Values in table for Flow Coefficient = 1.0. For well rounded nozzles, multiply by 0.97. For sharp edged nozzles, multiply by 0.65.

Air Hose Friction

Hose Size (inch)	CFM thru 50 ft Hose	Gage Pressure – Pounds-force/sq inch			
		50	70	90	110
		PSI Loss Over 50 foot Hose Length			
1/2	20	1.8	1.0	0.8	0.6
	30	5.0	3.4	2.4	2.0
	40	10.1	7.0	5.4	4.3
	50	18.1	12.4	9.5	7.6
	60	+	20.0	14.8	12.0
	70	+	28.4	22.0	17.6
	80	+	+	30.5	24.6
	90	+	+	41.0	33.3
	100	+	+	+	44.5
	110	+	+	+	+
3/4	20	0.4	0.2	0.2	0.1
	30	0.8	0.5	0.4	0.3
	40	1.5	0.9	0.7	0.5
	50	2.4	1.5	1.1	0.9
	60	3.5	2.3	1.6	1.3
	70	4.4	3.2	2.3	1.8
	80	6.5	4.2	3.1	2.4
	90	8.5	5.5	4.0	3.1
	100	11.4	7.0	5.0	3.9
	110	14.2	8.8	6.2	4.9
	120	+	11.0	7.5	5.9
	130	+	+	9.0	7.1
1	20	0.1	0.0	0.0	0.0
	30	0.2	0.1	0.1	0.1
	40	0.3	0.2	0.2	0.2
	50	0.5	0.4	0.3	0.2
	60	0.8	0.5	0.4	0.3
	70	1.1	0.7	0.6	0.4
	80	1.5	1.0	0.7	0.6
	90	2.0	1.3	0.9	0.7
	100	2.6	1.6	1.2	0.9
	110	3.5	2.0	1.4	1.1
	120	4.8	2.5	1.7	1.3
	130	7.0	3.1	2.0	1.5

PSI = Pressure in pounds-force/square inch
CFM = Air flow in cubic feet/minute

"+" means pressure loss is too great and therefore, the combination of Hose Size, CFM, and Gage Pressure is not recommended. Gage Pressure is the indicated air pressure, in pounds-force/square inch, at the source (ie, the air compressor receiver tank).

Air Line Recommended Sizes

Air Flow CFM	Length of Air Line in Feet 50	100	200	300
	Recommended Air Line Size in Inches			
5	1/2	1/2	1/2	1/2
10	1/2	1/2	1/2	3/4
15	1/2	1/2	3/4	3/4
20	1/2	3/4	3/4	3/4
25	3/4	3/4	1	1
30	3/4	3/4	1	1
35	3/4	3/4	1	1
40	3/4	1	1	1–1/4
50	1	1	1–1/4	1–1/4
75	1	1–1/4	1–1/4	1–1/4
100	1–1/4	1–1/4	1–1/2	1–1/2

Air Receiver Capacities

Tank Size (inches)	Tank Size (gallons)	Gauge Pressure on Tank (PSI) 0	100	150	200
		Cubic Feet Tank Capacity			
12 x 24	10	1.3	11	15	19
14 x 36	20	2.7	21	30	39
16 x 36	30	4.0	31	45	59
20 x 48	60	8.0	62	90	117
20 x 63	80	10.7	83	120	156
24 x 68	120	16.0	125	180	234
30 x 84	240	32.0	250	360	467

If your tank is not listed in the above table, use the following formula to calculate the Tank Size (gallons) and then estimate the Cubic Feet Tank Capacity at a given pressure from the table above.

$$\text{Tank Gallons} = \frac{\text{Tank Height} \times (\text{Tank Radius})^2}{73.53}$$

Height and Radius are in inches.

Limits for Air Contaminants

Pollutant	PEL[A]
Asbestos [B]	0.1 fiber / cc
Benzene [B]	1 ppm
Bromine	0.1 ppm
Cadmium (all forms) [C]	5 μg/m^3
Carbon dioxide	5,000 ppm
Carbon disulfide	20 ppm
Carbon monoxide	50 ppm
Carbon tetrachloride [C]	10 ppm
Chlorine	1 ppm [D]
Chloroform	50 ppm [D]
Cresol	5 ppm
Ethyl alcohol (ethanol)	1,000 ppm
Fluorine	.1 ppm
Formaldehyde [C]	0.75 ppm
Gasoline	300 ppm
Hydrogen cyanide	10 ppm
Iodine	0.1 ppm [D]
Iron oxide (fume)	10 mg/m^3
Isopropyl alcohol	400 ppm
Lead (all forms)	50 μg/m^3
Manganese compounds (as Mn)	5 mg/m^3
Mercury	1 mg/10 m^3 [D]
Methyl alcohol (methanol)	200 ppm
Nitric oxide	25 ppm
Nitrogen dioxide	5 ppm [D]
Propane [E]	1000 ppm
Selenium compounds (as Se)	0.2 mg/m^3
Sulfur dioxide	5 ppm
Sulfuric acid	1 mg/m^3
Tellurium compounds (as Te)	0.1 mg/m^3
Tetraethyl lead (as Pb)	0.075 mg/m^3
Toluene	200 ppm
Turpentine	100 ppm
Vinyl chloride [B]	1 ppm
Zinc oxide (fume)	5 mg/m^3
Zinc oxide (dust)	15 mg/m^3

Notes

A = PEL = Permissible Exposure Limit, 8-hour time weighted average
B = Confirmed human carcinogen
C = Suspected human carcinogen
D = Acceptable ceiling concentration
E = Simple asphyxiant

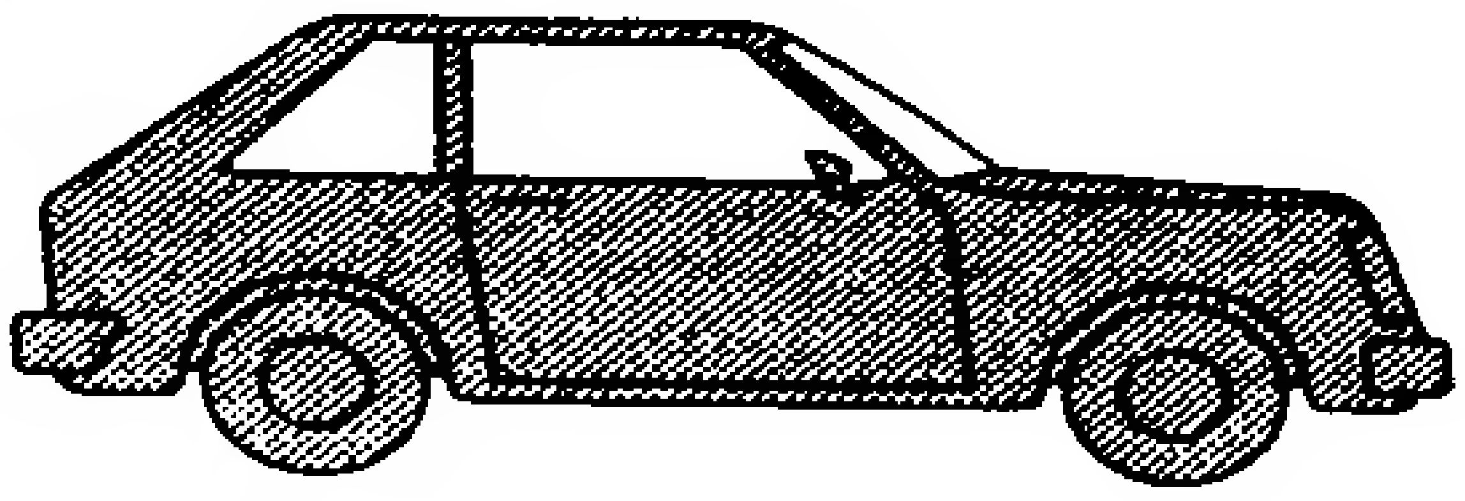
Abbreviations

cc = cubic centimeter
μg/m^3 = microgram per cubic meter
mg/m^3 = milligram per cubic meter
ppm = part per million

Source: *OSHA (Occupational Safety and Health Administration). [29 CFR 1920.1000,1001,1017,1025,1027,1028,1048]*

See also WATER Chapter for pollution, page 636

Automotive



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Miles per Gallon Fuel Chart

Miles Traveled	Gallons of Fuel Used													
	0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10	11
5	20.00	10.00	6.67	5.00	2.50	1.67	1.25	1.00	0.83	0.71	0.63	0.56	0.50	0.45
10	40.00	20.00	13.33	10.00	5.00	3.33	2.50	2.00	1.67	1.43	1.25	1.11	1.00	0.91
20	80.00	40.00	26.67	20.00	10.00	6.67	5.00	4.00	3.33	2.86	2.50	2.22	2.00	1.82
30	120.00	60.00	40.00	30.00	15.00	10.00	7.50	6.00	5.00	4.29	3.75	3.33	3.00	2.73
40	160.00	80.00	53.33	40.00	20.00	13.33	10.00	8.00	6.67	5.71	5.00	4.44	4.00	3.64
50	200.00	100.00	66.67	50.00	25.00	16.67	12.50	10.00	8.33	7.14	6.25	5.56	5.00	4.55
60	240.00	120.00	80.00	60.00	30.00	20.00	15.00	12.00	10.00	8.57	7.50	6.67	6.00	5.45
70	280.00	140.00	93.33	70.00	35.00	23.33	17.50	14.00	11.67	10.00	8.75	7.78	7.00	6.36
80	320.00	160.00	106.67	80.00	40.00	26.67	20.00	16.00	13.33	11.43	10.00	8.89	8.00	7.27
90	360.00	180.00	120.00	90.00	45.00	30.00	22.50	18.00	15.00	12.86	11.25	10.00	9.00	8.18
100	400.00	200.00	133.33	100.00	50.00	33.33	25.00	20.00	16.67	14.29	12.50	11.11	10.00	9.09
110	440.00	220.00	146.67	110.00	55.00	36.67	27.50	22.00	18.33	15.71	13.75	12.22	11.00	10.00
120	480.00	240.00	160.00	120.00	60.00	40.00	30.00	24.00	20.00	17.14	15.00	13.33	12.00	10.91
130	520.00	260.00	173.33	130.00	65.00	43.33	32.50	26.00	21.67	18.57	16.25	14.44	13.00	11.82
140	560.00	280.00	186.67	140.00	70.00	46.67	35.00	28.00	23.33	20.00	17.50	15.56	14.00	12.73
150	600.00	300.00	200.00	150.00	75.00	50.00	37.50	30.00	25.00	21.43	18.75	16.67	15.00	13.64
160	640.00	320.00	213.33	160.00	80.00	53.33	40.00	32.00	26.67	22.86	20.00	17.78	16.00	14.55
170	680.00	340.00	226.67	170.00	85.00	56.67	42.50	34.00	28.33	24.29	21.25	18.89	17.00	15.45
180	720.00	360.00	240.00	180.00	90.00	60.00	45.00	36.00	30.00	25.71	22.50	20.00	18.00	16.36
190	760.00	380.00	253.33	190.00	95.00	63.33	47.50	38.00	31.67	27.14	23.75	21.11	19.00	17.27
200	800.00	400.00	266.67	200.00	100.00	66.67	50.00	40.00	33.33	28.57	25.00	22.22	20.00	18.18
210	840.00	420.00	280.00	210.00	105.00	70.00	52.50	42.00	35.00	30.00	26.25	23.33	21.00	19.09
220	880.00	440.00	293.33	220.00	110.00	73.33	55.00	44.00	36.67	31.43	27.50	24.44	22.00	20.00
230	920.00	460.00	306.67	230.00	115.00	76.67	57.50	46.00	38.33	32.86	28.75	25.56	23.00	20.91
240	960.00	480.00	320.00	240.00	120.00	80.00	60.00	48.00	40.00	34.29	30.00	26.67	24.00	21.82
250	1000.00	500.00	333.33	250.00	125.00	83.33	62.50	50.00	41.67	35.71	31.25	27.78	25.00	22.73
260	1040.00	520.00	346.67	260.00	130.00	86.67	65.00	52.00	43.33	37.14	32.50	28.89	26.00	23.64
270	1080.00	540.00	360.00	270.00	135.00	90.00	67.50	54.00	45.00	38.57	33.75	30.00	27.00	24.55
280	1120.00	560.00	373.33	280.00	140.00	93.33	70.00	56.00	46.67	40.00	35.00	31.11	28.00	25.45
290	1160.00	580.00	386.67	290.00	145.00	96.67	72.50	58.00	48.33	41.43	36.25	32.22	29.00	26.36

Miles per Gallon Fuel Chart (cont.)

Miles Traveled	Gallons of Fuel Used													
	0.25	0.5	0.75	1	2	3	4	5	6	7	8	9	10	11
300	1200.00	600.00	400.00	300.00	150.00	100.00	75.00	60.00	50.00	42.86	37.50	33.33	30.00	27.27
310	1240.00	620.00	413.33	310.00	155.00	103.33	77.50	62.00	51.67	44.29	38.75	34.44	31.00	28.18
320	1280.00	640.00	426.67	320.00	160.00	106.67	80.00	64.00	53.33	45.71	40.00	35.56	32.00	29.09
330	1320.00	660.00	440.00	330.00	165.00	110.00	82.50	66.00	55.00	47.14	41.25	36.67	33.00	30.00
340	1360.00	680.00	453.33	340.00	170.00	113.33	85.00	68.00	56.67	48.57	42.50	37.78	34.00	30.91
350	1400.00	700.00	466.67	350.00	175.00	116.67	87.50	70.00	58.33	50.00	43.75	38.89	35.00	31.82
360	1440.00	720.00	480.00	360.00	180.00	120.00	90.00	72.00	60.00	51.43	45.00	40.00	36.00	32.73
370	1480.00	740.00	493.33	370.00	185.00	123.33	92.50	74.00	61.67	52.86	46.25	41.11	37.00	33.64
380	1520.00	760.00	506.67	380.00	190.00	126.67	95.00	76.00	63.33	54.29	47.50	42.22	38.00	34.55
390	1560.00	780.00	520.00	390.00	195.00	130.00	97.50	78.00	65.00	55.71	48.75	43.33	39.00	35.45
400	1600.00	800.00	533.33	400.00	200.00	133.33	100.00	80.00	66.67	57.14	50.00	44.44	40.00	36.36
410	1640.00	820.00	546.67	410.00	205.00	136.67	102.50	82.00	68.33	58.57	51.25	45.56	41.00	37.27
420	1680.00	840.00	560.00	420.00	210.00	140.00	105.00	84.00	70.00	60.00	52.50	46.67	42.00	38.18
430	1720.00	860.00	573.33	430.00	215.00	143.33	107.50	86.00	71.67	61.43	53.75	47.78	43.00	39.09
440	1760.00	880.00	586.67	440.00	220.00	146.67	110.00	88.00	73.33	62.86	55.00	48.89	44.00	40.00
450	1800.00	900.00	600.00	450.00	225.00	150.00	112.50	90.00	75.00	64.29	56.25	50.00	45.00	40.91
460	1840.00	920.00	613.33	460.00	230.00	153.33	115.00	92.00	76.67	65.71	57.50	51.11	46.00	41.82
470	1880.00	940.00	626.67	470.00	235.00	156.67	117.50	94.00	78.33	67.14	58.75	52.22	47.00	42.73
480	1920.00	960.00	640.00	480.00	240.00	160.00	120.00	96.00	80.00	68.57	60.00	53.33	48.00	43.64
490	1960.00	980.00	653.33	490.00	245.00	163.33	122.50	98.00	81.67	70.00	61.25	54.44	49.00	44.55
500	2000.00	1000.00	666.67	500.00	250.00	166.67	125.00	100.00	83.33	71.43	62.50	55.56	50.00	45.45
510	2040.00	1020.00	680.00	510.00	255.00	170.00	127.50	102.00	85.00	72.86	63.75	56.67	51.00	46.36
520	2080.00	1040.00	693.33	520.00	260.00	173.33	130.00	104.00	86.67	74.29	65.00	57.78	52.00	47.27
530	2120.00	1060.00	706.67	530.00	265.00	176.67	132.50	106.00	88.33	75.71	66.25	58.89	53.00	48.18
540	2160.00	1080.00	720.00	540.00	270.00	180.00	135.00	108.00	90.00	77.14	67.50	60.00	54.00	49.09
550	2200.00	1100.00	733.33	550.00	275.00	183.33	137.50	110.00	91.67	78.57	68.75	61.11	55.00	50.00
560	2240.00	1120.00	746.67	560.00	280.00	186.67	140.00	112.00	93.33	80.00	70.00	62.22	56.00	50.91
570	2280.00	1140.00	760.00	570.00	285.00	190.00	142.50	114.00	95.00	81.43	71.25	63.33	57.00	51.82
580	2320.00	1160.00	773.33	580.00	290.00	193.33	145.00	116.00	96.67	82.86	72.50	64.44	58.00	52.73
590	2360.00	1180.00	786.67	590.00	295.00	196.67	147.50	118.00	98.33	84.29	73.75	65.56	59.00	53.64
600	2400.00	1200.00	800.00	600.00	300.00	200.00	150.00	120.00	100.00	85.71	75.00	66.67	60.00	54.55

Miles per Gallon Fuel Chart (cont.)

Miles Traveled	Gallons of Fuel Used													
	12	13	14	15	16	17	18	19	20	21	22	23	24	25
5	0.42	0.38	0.36	0.33	0.31	0.29	0.28	0.26	0.25	0.24	0.23	0.22	0.21	0.20
10	0.83	0.77	0.71	0.67	0.63	0.59	0.56	0.53	0.50	0.48	0.45	0.43	0.42	0.40
20	1.67	1.54	1.43	1.33	1.25	1.18	1.11	1.05	1.00	0.95	0.91	0.87	0.83	0.80
30	2.50	2.31	2.14	2.00	1.88	1.76	1.67	1.58	1.50	1.43	1.36	1.30	1.25	1.20
40	3.33	3.08	2.86	2.67	2.50	2.35	2.22	2.11	2.00	1.90	1.82	1.74	1.67	1.60
50	4.17	3.85	3.57	3.33	3.13	2.94	2.78	2.63	2.50	2.38	2.27	2.17	2.08	2.00
60	5.00	4.62	4.29	4.00	3.75	3.53	3.33	3.16	3.00	2.86	2.73	2.61	2.50	2.40
70	5.83	5.38	5.00	4.67	4.38	4.12	3.89	3.68	3.50	3.33	3.18	3.04	2.92	2.80
80	6.67	6.15	5.71	5.33	5.00	4.71	4.44	4.21	4.00	3.81	3.64	3.48	3.33	3.20
90	7.50	6.92	6.43	6.00	5.63	5.29	5.00	4.74	4.50	4.29	4.09	3.91	3.75	3.60
100	8.33	7.69	7.14	6.67	6.25	5.88	5.56	5.26	5.00	4.76	4.55	4.35	4.17	4.00
110	9.17	8.46	7.86	7.33	6.88	6.47	6.11	5.79	5.50	5.24	5.00	4.78	4.58	4.40
120	10.00	9.23	8.57	8.00	7.50	7.06	6.67	6.32	6.00	5.71	5.45	5.22	5.00	4.80
130	10.83	10.00	9.29	8.67	8.13	7.65	7.22	6.84	6.50	6.19	5.91	5.65	5.42	5.20
140	11.67	10.77	10.00	9.33	8.75	8.24	7.78	7.37	7.00	6.67	6.36	6.09	5.83	5.60
150	12.50	11.54	10.71	10.00	9.38	8.82	8.33	7.89	7.50	7.14	6.82	6.52	6.25	6.00
160	13.33	12.31	11.43	10.67	10.00	9.41	8.89	8.42	8.00	7.62	7.27	6.96	6.67	6.40
170	14.17	13.08	12.14	11.33	10.63	10.00	9.44	8.95	8.50	8.10	7.73	7.39	7.08	6.80
180	15.00	13.85	12.86	12.00	11.25	10.59	10.00	9.47	9.00	8.57	8.18	7.83	7.50	7.20
190	15.83	14.62	13.57	12.67	11.88	11.18	10.56	10.00	9.50	9.05	8.64	8.26	7.92	7.60
200	16.67	15.38	14.29	13.33	12.50	11.76	11.11	10.53	10.00	9.52	9.09	8.70	8.33	8.00
210	17.50	16.15	15.00	14.00	13.13	12.35	11.67	11.05	10.50	10.00	9.55	9.13	8.75	8.40
220	18.33	16.92	15.71	14.67	13.75	12.94	12.22	11.58	11.00	10.48	10.00	9.57	9.17	8.80
230	19.17	17.69	16.43	15.33	14.38	13.53	12.78	12.11	11.50	10.95	10.45	10.00	9.58	9.20
240	20.00	18.46	17.14	16.00	15.00	14.12	13.33	12.63	12.00	11.43	10.91	10.43	10.00	9.60
250	20.83	19.23	17.86	16.67	15.63	14.71	13.89	13.16	12.50	11.90	11.36	10.87	10.42	10.00
260	21.67	20.00	18.57	17.33	16.25	15.29	14.44	13.68	13.00	12.38	11.82	11.30	10.83	10.40
270	22.50	20.77	19.29	18.00	16.88	15.88	15.00	14.21	13.50	12.86	12.27	11.74	11.25	10.80
280	23.33	21.54	20.00	18.67	17.50	16.47	15.56	14.74	14.00	13.33	12.73	12.17	11.67	11.20
290	24.17	22.31	20.71	19.33	18.13	17.06	16.11	15.26	14.50	13.81	13.18	12.61	12.08	11.60